

# Offshore wind turbine blade certification – challenges and opportunities

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# The undisputed **global leader** in wind energy



**~29,000**

employees

Every day, our employees help create a better world by designing, manufacturing, installing, developing, and servicing wind energy and hybrid projects all over the world



**+50,000**

turbines under service

Our service technicians keep the world spinning by servicing a global portfolio of more than 147 GW - the largest fleet in the world



**167 GW**

installed wind turbine capacity

We have installed more wind turbine capacity than any other company in the world, with installations in 89 countries



**222m**

tonnes CO<sub>2</sub>e avoided annually

Our total aggregated installed fleet annually help the World avoid emissions of 222 million tonnes CO<sub>2</sub>e

# Vestas is solidified as the industry leader

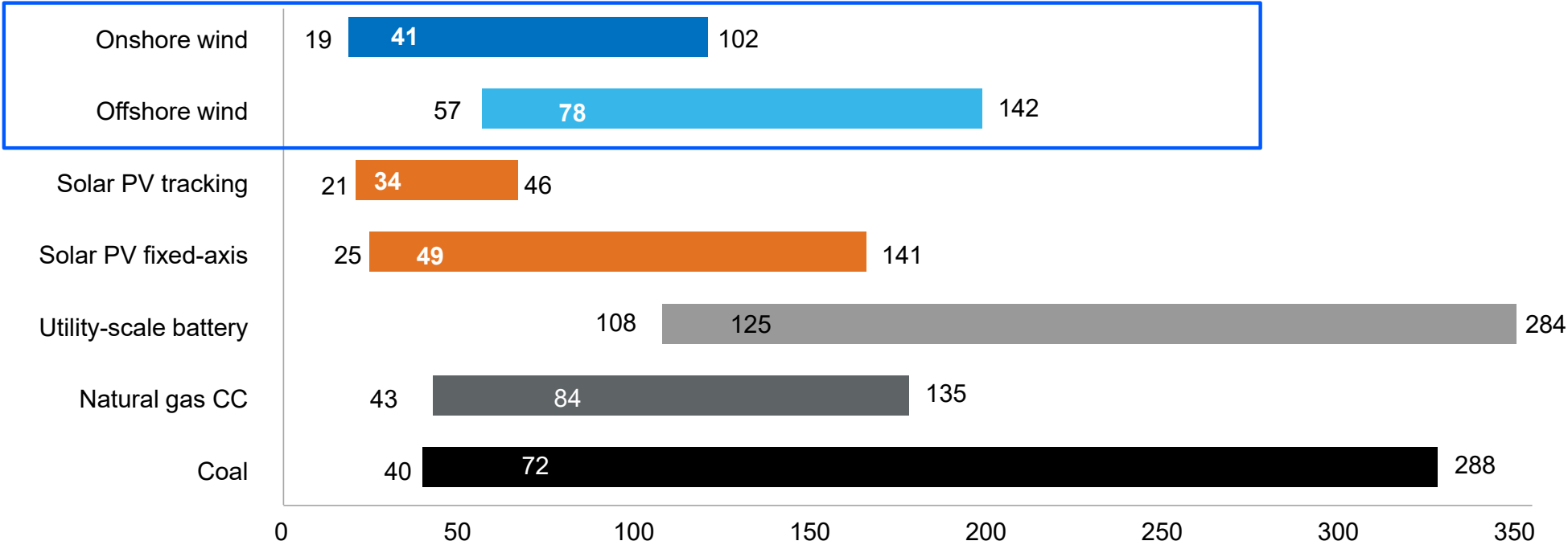


Source: Wood Mackenzie; Company financial reports leading Western OEMs

# After over 40 years, wind is one of the most affordable sources of energy

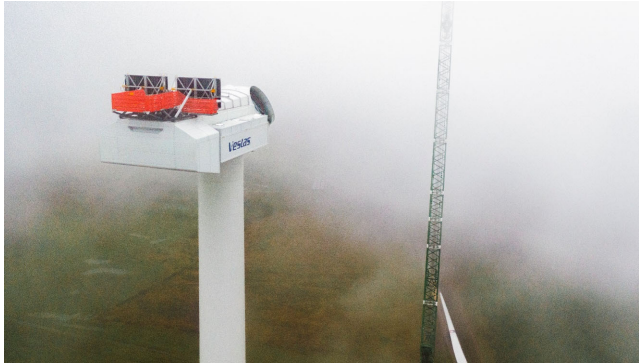
Global Levelised Cost of Energy (LCOE) ranges \$/MWh

Median



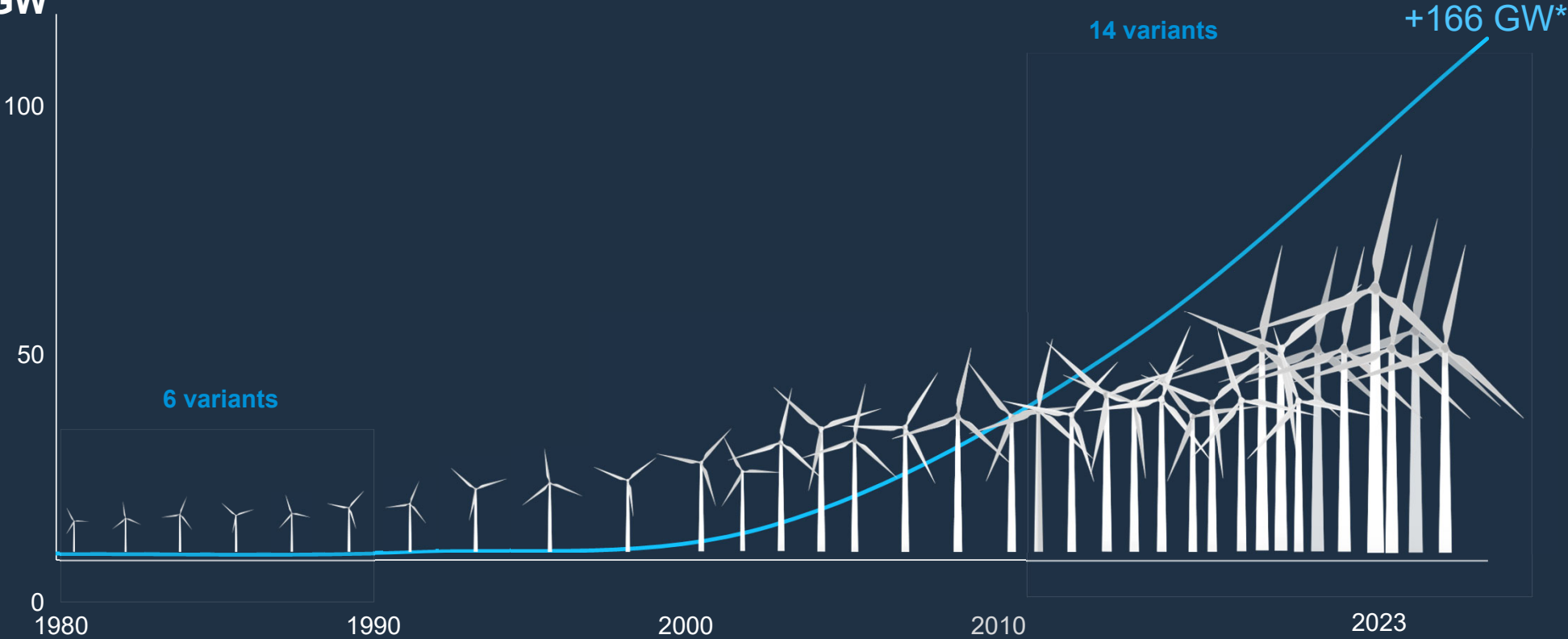
# V236-15.0 MW

## Prototype



# The pace of innovation brings risks and complexity to Vestas' technology

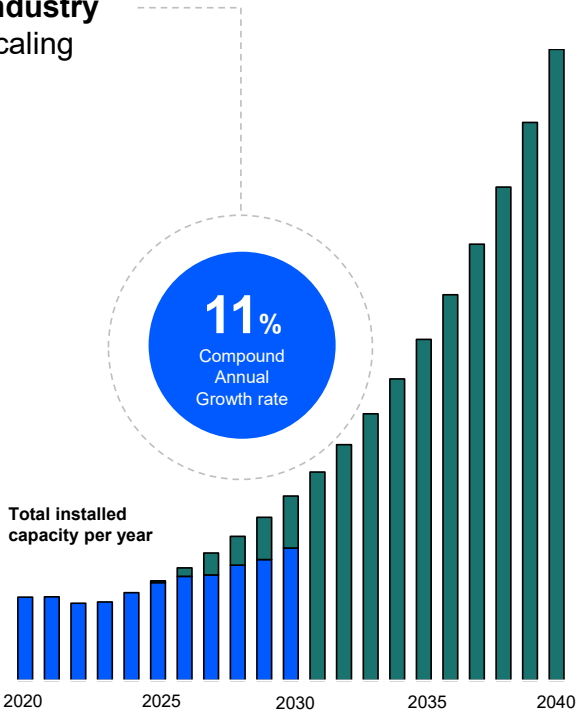
## Vestas' installed wind power GW



06 September 2023

# Industry growth potential & market dynamics demand effective solutions

Industry scaling



Differentiated application



Challenged value chain



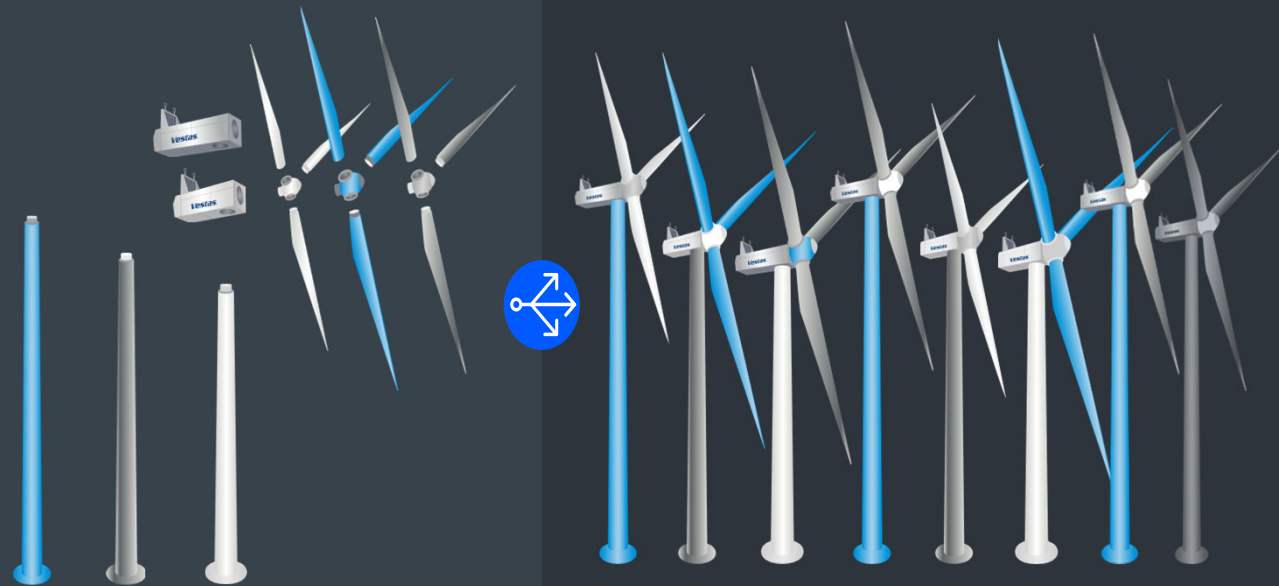
## Future trends

In the last 20 years, Vestas blade product has increased X2.6 in rotor diameter and around X10 in blade mass

Where will the next 10 years go for blades?

- Value chain cost to develop and deliver large technology steps is prohibitive
- Quality suffers if technical expansion is too fast

Modularisation can provide a solution to continually increase customer value while maintaining simplicity



Current testing guidelines are not set up with multiple very similar products



## Blades testing status

- Vestas tests approximately 5 blades per year
- Duration of a test campaign around 1 year
- Total cost of offshore testing, including manufacture and transportation of the test blade is several million euros per test
- Size affects fatigue testing – often accelerating tests can lead to millions of cycles above extreme load levels
- Costs can escalate quickly if things go wrong



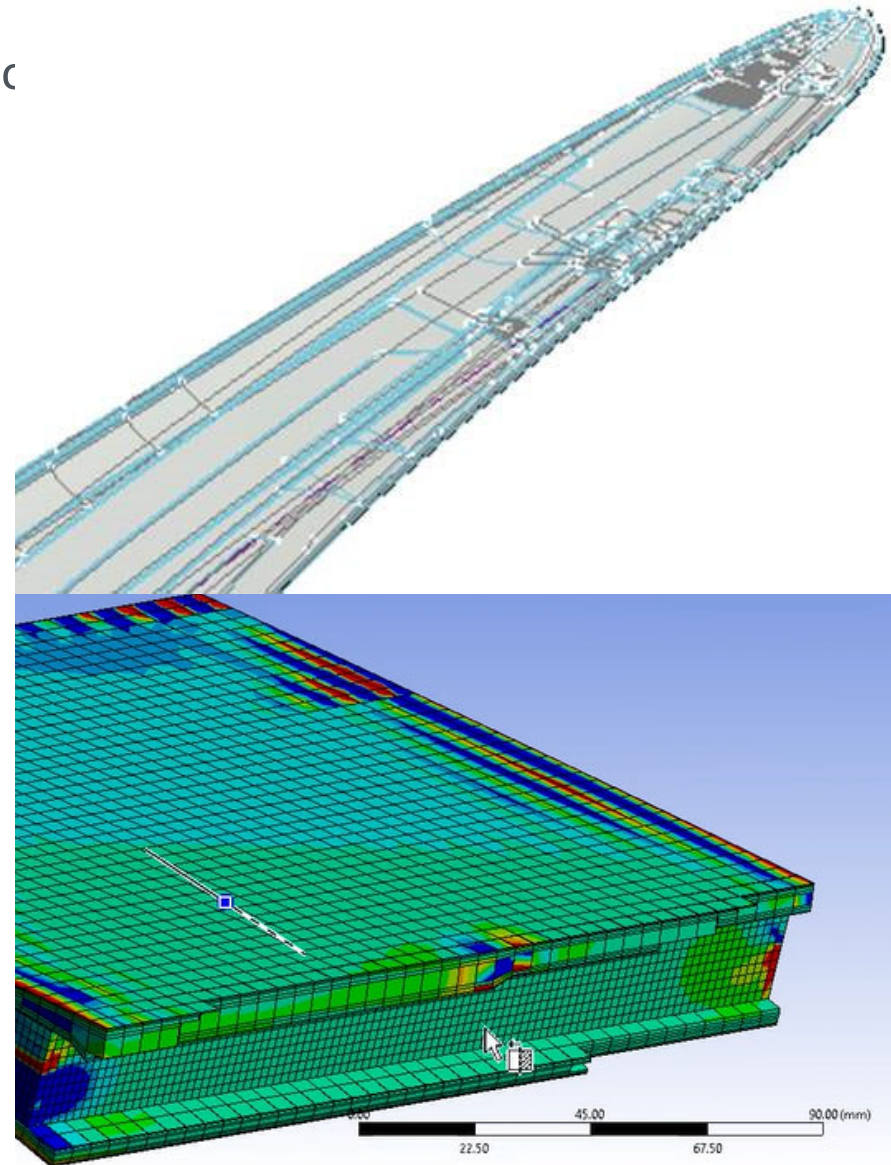
Testing time and cost is hugely increased with large blades

## Transformation – Excellence in digital design methc

### Heavy investment in digital solutions

- Single sourced ply based design capability covering global and detailed FEA, process simulation and CAD
- Extensive submodelling with particular focus on bondline strength and robustness
- Expansion of digital capabilities in fracture toughness, process simulation, fibre failure and automated toolsets

Increased capability in digital design reduces reliance on full scale blade testing and provides a significant increase in design understanding



## Transformation – Substructure scale testing

Vestas uses substructural testing significantly in our development process

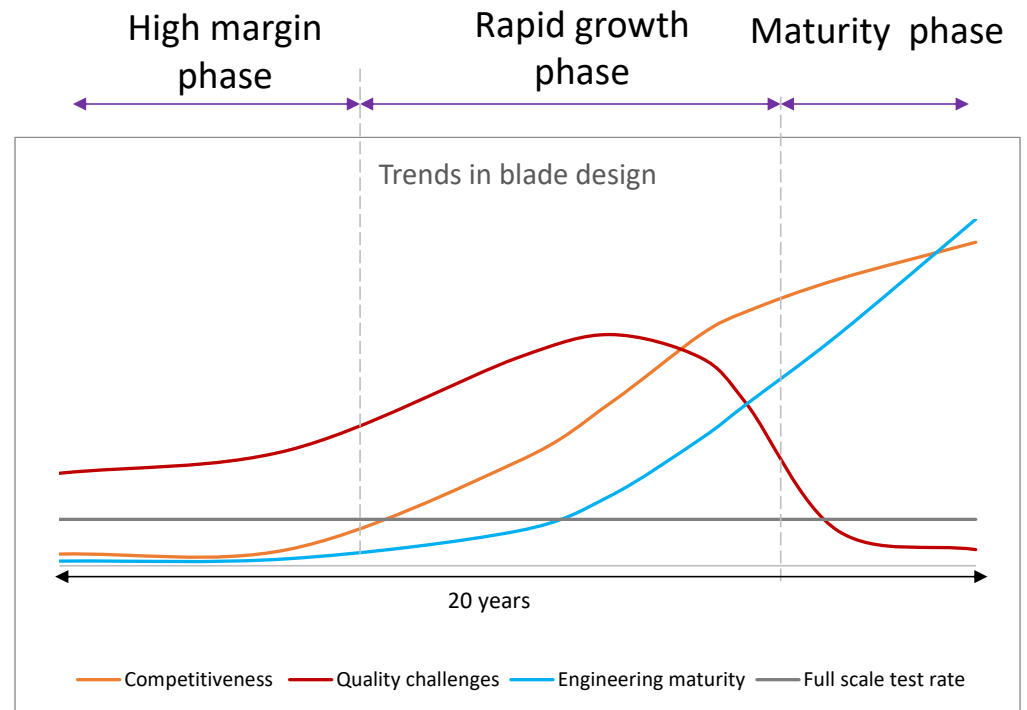
- Multiple design points can be investigated
- Multiple defects and repair methods can be characterised
- Tests can easily be taken to failure (hard and expensive to do at full scale)
- High potential for use in reliability type analyses
- Example track record:
  - >100 beams tested
  - >4000 root inserts tested

For the same investment Vestas can either test a single test blade or a huge number of substructure coupons – which will bring more value to us

## Industry trends

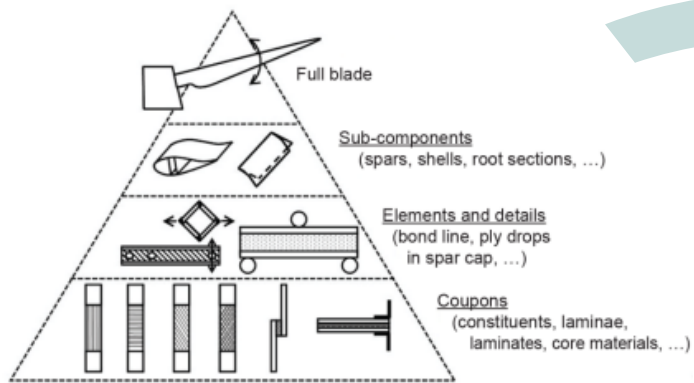
The wind industry has been characterised by 3 phases during the last 20 years

- High margin phase characterised by high margin designs, low engineering maturity and moderate quality challenges
- Rapid growth phase characterised by rapidly reducing design margins, lower costs but high quality challenges and low engineering maturity
- Maturity phase characterised by significant increase in engineering capabilities (digital, substructural) enabling safe technology and product release

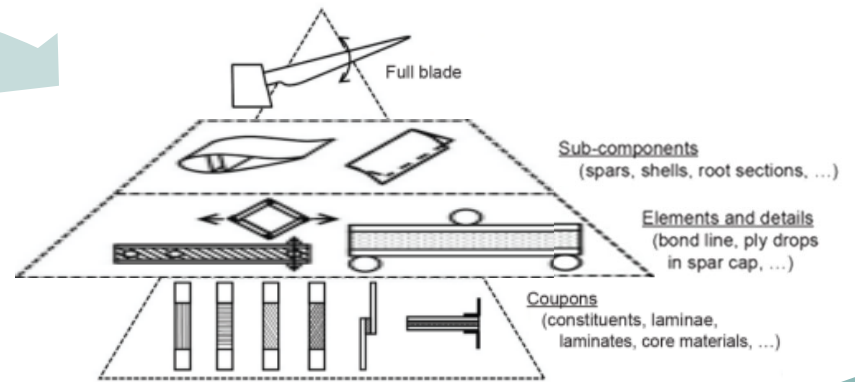


Across all 3 phases the full scale testing requirements have remained unchanged

# Test pyramid trends within Vestas

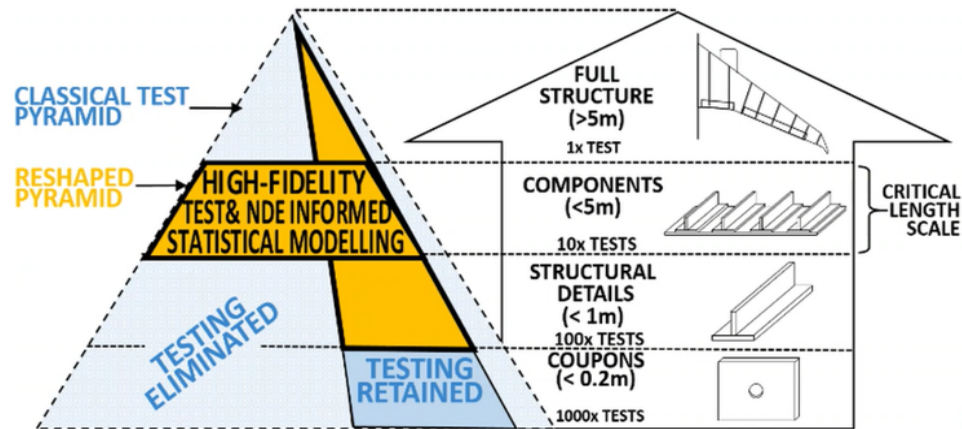


1) Historic test pyramid

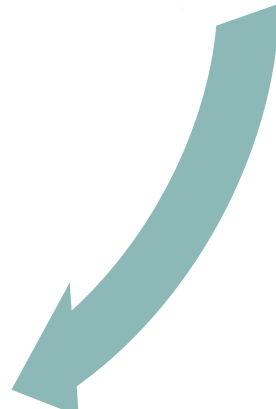


2) Current test pyramid

CERTEST gives us a framework to capitalise on our investments in subcomponent testing in risk reduction and cost saving through framework improvement.



3) Future potential test pyramid (CERTEST)



## Opportunity in the wind industry

Vestas gets high value from digital/substructural methods

- Cost is low
- Learnings are high
- Reliability perspective exists

Full scale testing is costly, time consuming and provides less value if digital/substructural work is done well

Moving towards less dependence on full scale testing can benefit the industry as a whole by focussing on the value added digital and substructural activities



The image shows a large white wind turbine in the foreground, with several other turbines visible in the background. The scene is set in a rural landscape with green and brown fields under a clear sky. Three people are standing on the nacelle of the turbine in the foreground. The Vestas logo is positioned in the upper left corner.

**Vestas**

**Wind.** It means the world to us.™

Thank you for your attention

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